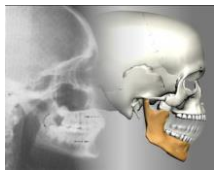
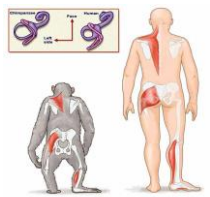


Biomechanics

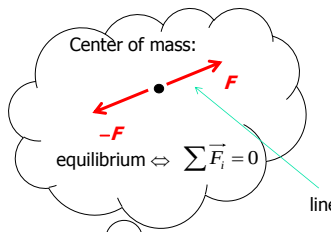




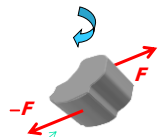
Statics of the rigid body

Point-like mass body: ⟺ Extended rigid body:

Center of mass:



equilibrium ⇔ $\sum \vec{F}_i = 0$

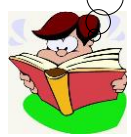


$\sum \vec{F}_i = 0$

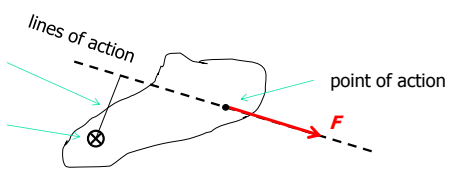
lines of action

Rotation is possible!

(if the forces have no common line of action)



Statics of the rigid body – torque



torque (*M*):

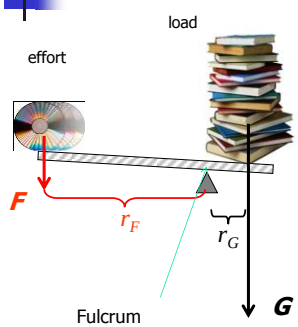
(moment or moment of force

- tendency of a force or forces to rotate an object)

$M = r \cdot F$ Unit: Nm

equilibrium ⇔ $\sum \vec{F}_i = 0$ and $\sum M_i = 0$

Lever: a simple machine



Equilibrium:

$\sum M_i = 0$

$r_G \cdot G = M_G = M_F = r_F \cdot F$

$\frac{G}{F} = \frac{r_F}{r_G}$

Mechanical advantage: increased force

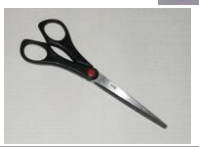
$\frac{G}{F}$

Examples









5

Types

Class 1

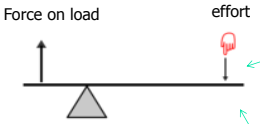
Fulcrum between the effort and load.

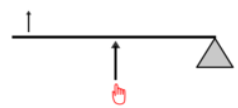
Class 2

The effort and load on the same side.

Class 3

mechanical disadvantage, distance moved by the load is greater.



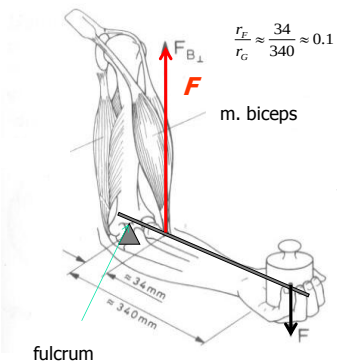





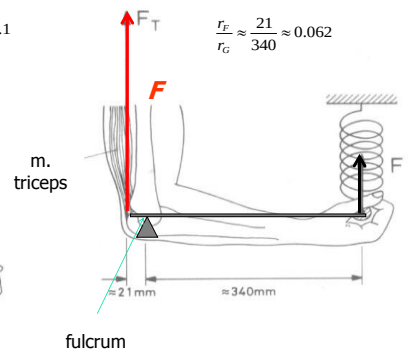
6

In the human body

Arm:



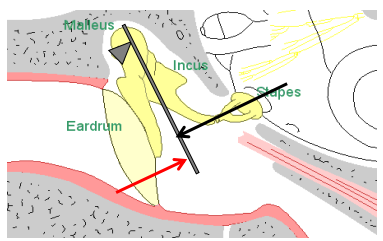
Class 3



Class 1

7

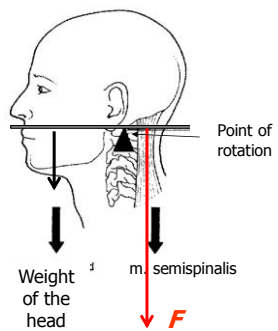
Ear bones:



Class 2

Holding the head:

Class 1



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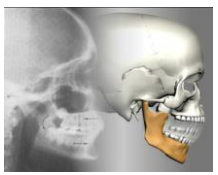
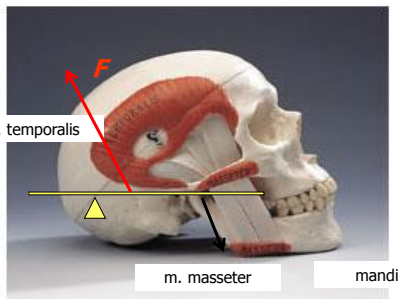
Class 3

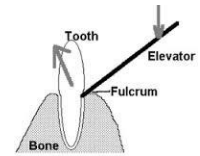
chewing:



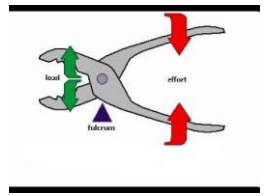


In dentistry

elevators



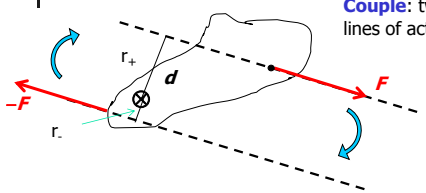
forceps



Class 1

10

Couple

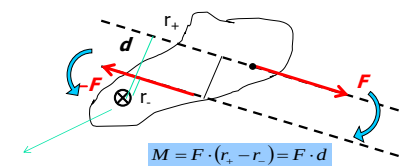


Couple: two equal and opposite forces whose lines of action do not coincide.

$$F = F_+ + F_- = 0$$

Resultant force: 0

$$M = F \cdot (r_- + r_+) = F \cdot d$$



Resultant torque (M)

$$M = d \cdot F$$

(independent of reference point)

$$M = F \cdot (r_+ - r_-) = F \cdot d$$

Reference point

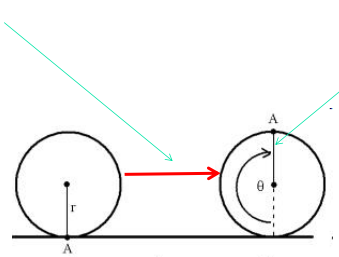
11

System of forces

Any system of forces may be replaced by a force and a couple!

Force:
results only translational motion

Couple:
results only rotation



Compaund motion (translational motion and rotation

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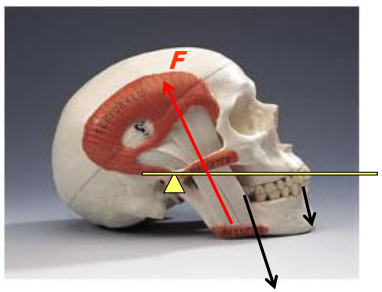
Masticatory force

Jaw elevators and depressors



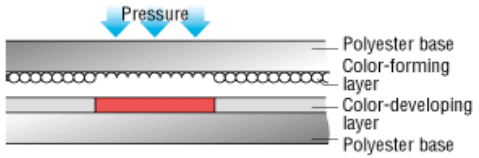
Force system

about 10 000 N

(Guinness recorf: human - 4000 N)

Measurement of the masticatory force

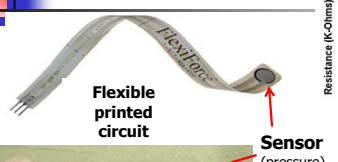
Pressure indicating film:



micro-encapsulated color forming and developing material

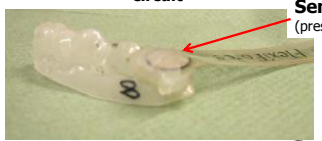
Piezoelectric sensor:

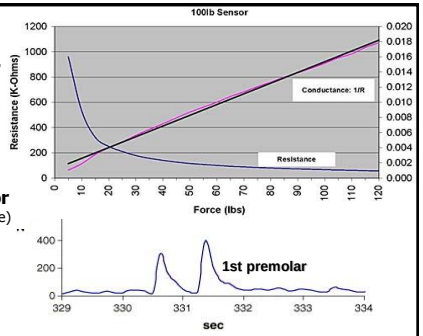
(look at piezoelectric effect!)



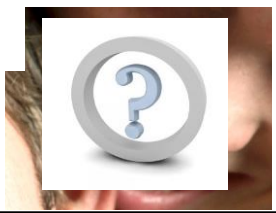
Flexible printed circuit

Sensor (pressure)



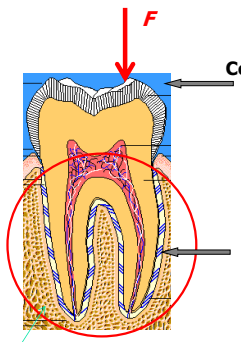


Other (subjective) methods:



Transmission of forces to the bones

Typical load type (input):

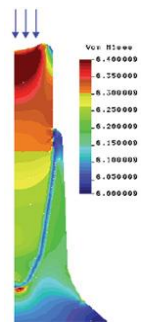


Concentrated pressure

Typical load type (output):

Spaced tensile stress

(distributed on the surface)

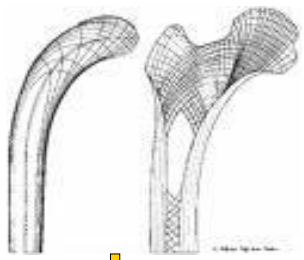


root

Constructive effect on the bone!

Bone remodeling

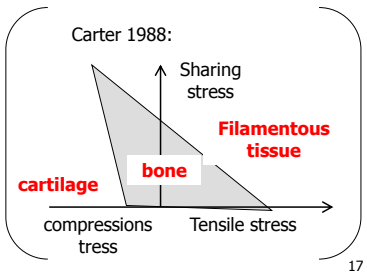
Wolff's law 1870: the bone in a healthy person will adapt to the loads.



The role of the load

Compression stress ⇒ bone resorption

Tensile stress ⇒ ossification



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Mechanism of bone remodeling

mechanical load

⇓

electric signal (piezoelectric/flow potential)

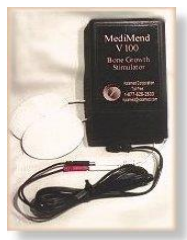
⇓

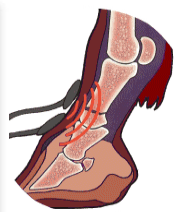
Regulation of the ossification (osteogenesys)

⇓

mechanical adaptation

Application of electric fields in the stimulation of bone healing:





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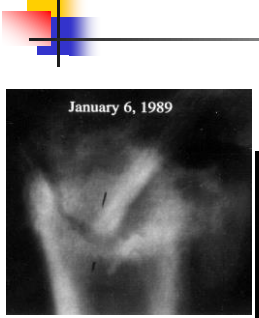
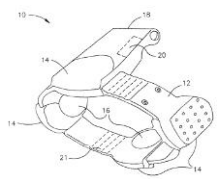
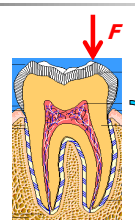




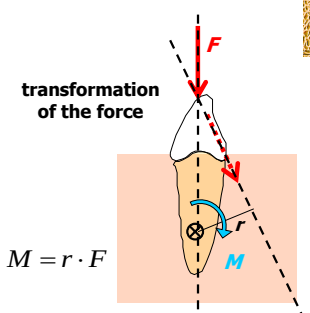
Torque of the masticatory forces



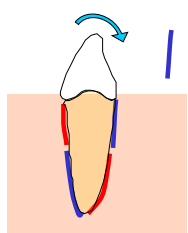
Memo:

compression stress ⇒ bone resorption

tensile stress ⇒ ossification



$M = r \cdot F$



+compression stress

+tensile stress !

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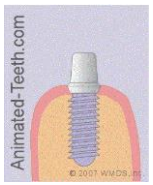
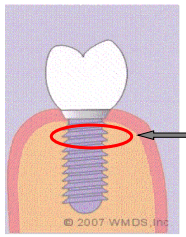
Force transmission of dental implant



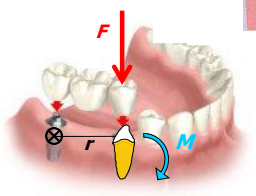
typical: titanium screw

osseointegration → **Compression stress!**

No force distribution!

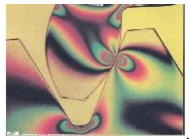


stress concentration



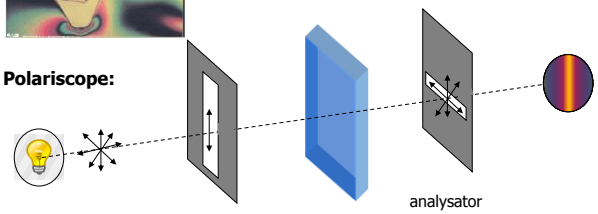
→ large torque

Physical testing methods in implantology



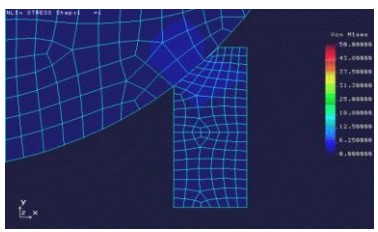
- Stress-optic method

Polariscope:



Distribution of the stress

Computer based method



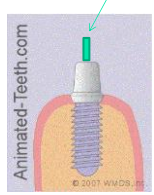
- **finite element method**

Calculation on a model.

Stability test

- **Resonance Frequency Analysis** (**RFA**) is a method used to determine stability in dental implants.

small magnet



magnetic pulses are applied to a small magnet and the resonance is analysed.

- **Periotest**

Electrically driven head percusses the implant and the response is monitored.